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(56) Documents cited
GB 1561667 GB 1289146 GB 0621489
GB 1364845

(58) Field of search
G1A

(54) Monitoring condition of surface

(57) A surface-condition detection and/or monitoring arrangement comprises input and output optical fibres 1,2 having ends terminating in close proximity at the surface 4 being monitored (e.g. aircraft wing surface or rotor blade surface of helicopter). Source 5 applies light signals to the input optical fibre 1 which is so arranged relative to the output optical fibre that light emerging at the surface 4 will be variably reflected and scattered by surface ice, water, oil, etc, into the adjacent end of the output fibre 2. Detection means 8 is provided at the far end of the output fibre for detecting and analysing the light output at different wavelengths to determine and provide an indication of the presence and/or composition of any film on the surface 4.

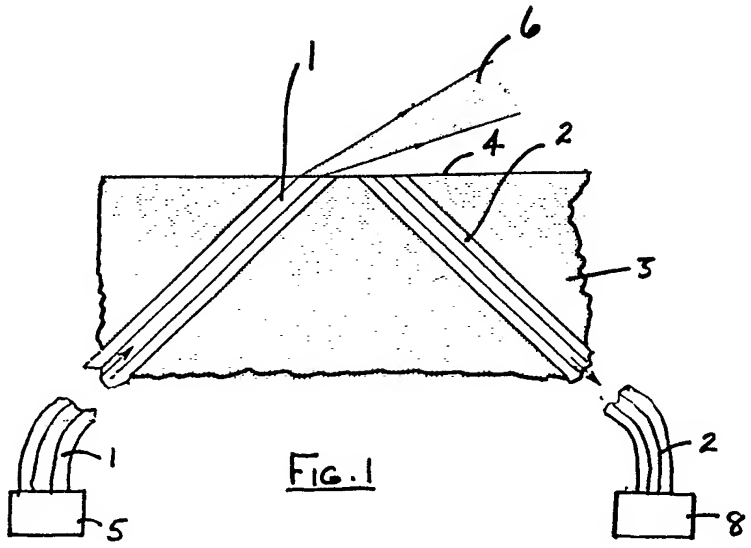

FIG. 1

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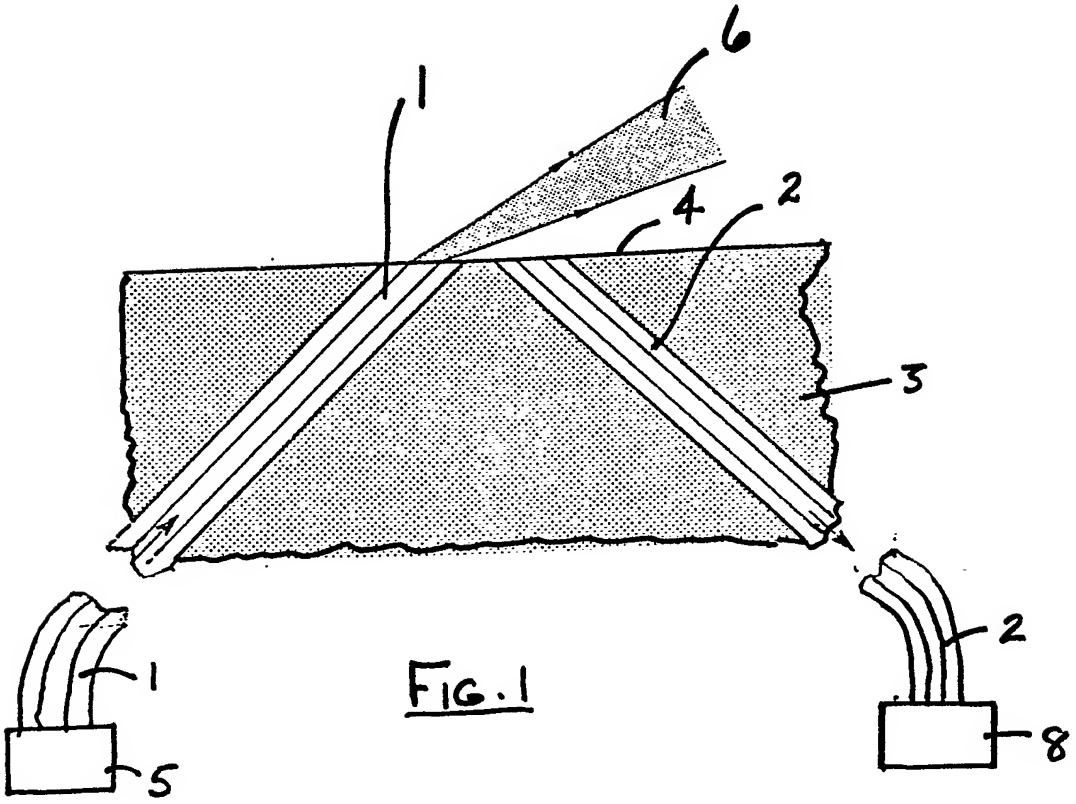

FIG. 1

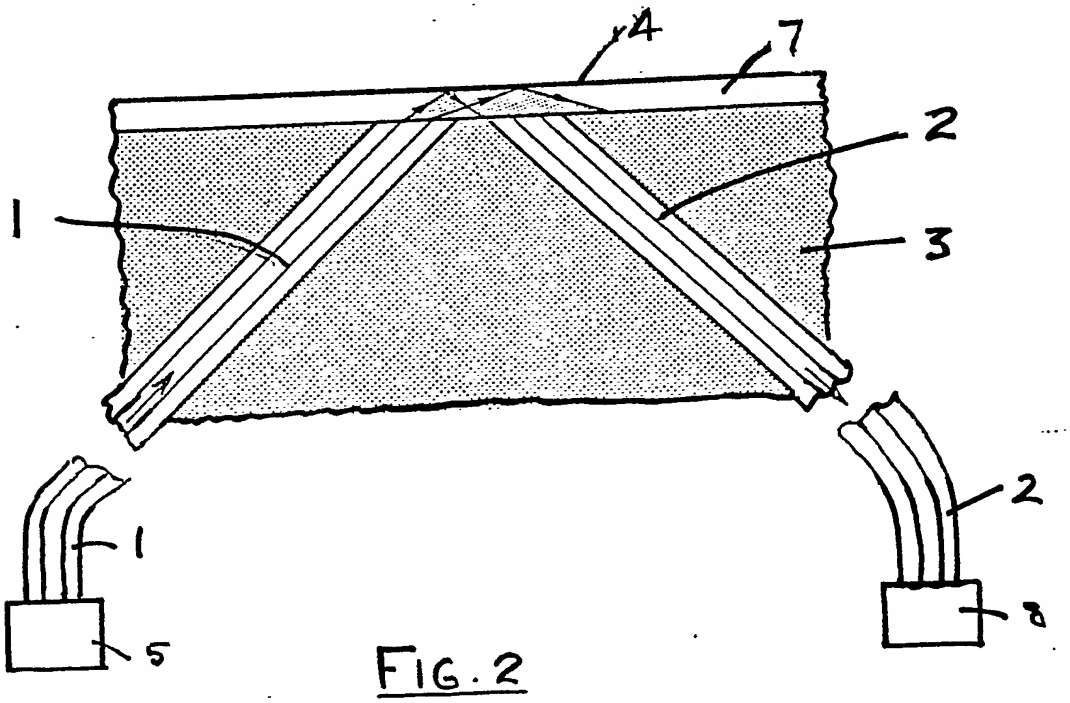

FIG. 2

SPECIFICATION

Improvements relating to the detection and/ or monitoring of surface conditions

This invention relates to arrangements for detecting and/or monitoring surface conditions.(e.g. ice, water and oil films etc.) and is especially concerned with the detection of ice on the wings or rotor blade surfaces of aircraft.

According to the present invention there is provided a surface-condition detection and/or monitoring arrangement comprising input and output optical fibres having ends thereof terminating in close proximity with one another at the surface concerned (e.g. aircraft wing surface or rotor blade surface of helicopter) means for generating and applying light signals to the input optical fibre which is so arranged relative to the output optical fibre that light emerging from the end of the input optical fibre terminated at said surface, will be variably reflected and scattered by surface ice, water, oil, etc, into the end of the output optical fibre, detection means being provided at the far end of the output fibre for detecting and analysing the light output to determine and provide an indication of surface conditions.

When the surface being monitored is free of ice, water, oil, etc, substantially none of the light emerging from the input optical fibre will enter the output fibre.

One of the principal advantages of the present invention, is that it does not require any part of the detection monitoring arrangement to project from the surface being monitored since the adjacent ends of the input and output optical fibres effectively form part of the surface being monitored. For this reason, the detection arrangement will be less vulnerable to damage than condition detecting arrangements already known.

The optical spectrum of the light output (or part of that spectrum) may by analysed by the analysing means to determine the composition of the surface film producing reflection and scattering of the light.

In order to distinguish between the light transmitted through the optical fibres and the ambient light, the light applied to the fibres may be of periodically-varying intensity in order to provide an alternating component to the light which can be detected by the detector analyser means.

By way of example, the present invention will now be described with reference to the accompanying drawing, in which:

Figures 1 and 2 are diagrams of the optical fibre surface-condition detector arrangement and illustrates the mode of operation of the arrangement.

Referring to Fig. 1, the detector arrangement comprises input and output optical fibres 1 and 2, which in the present example are embodied in a structure 3 which may be the wing of an aircraft. The upper ends of the optical fibres 1 and 2, as viewed in the Figure are terminated adjacent one another and flush with the surface 4 of the structure 3 so that they effectively define a continuation of the surface 4. In operation of the surface-condition detection/monitoring arrangement, the input end of the input optical fibre 1 will have a light signal applied to it from a light source 5. This light signal is preferably of periodically-varying intensity so that the detector arrangement can distinguish positively from ambient light impinging on the arrangement.

This periodically-varying light signal travels along the input fibre 1 until it reaches the end thereof. When the surface 4 is not covered with a transparent or translucent film of water, ice, oil, etc, the light emerging from the end of the fibre 1 defines a light beam 6 which radiates into the atmosphere above the surface 4 so that virtually none of the light beam 6 enters the output fibre 2.

However, in the presence of a film 7 of water, ice or oil, on the surface 4, as shown in Fig. 2, the light beam emerging from the input fibre 1 will be internally reflected by the film 7 so that a significant proportion of the light emerging from the optical fibre 1 enters the end of the output optical fibre 2. This light travels along the output fibre 2 and is detected and analysed at the far end of the optical fibre 2 by means of a detector/analyser means 8.

The detector/analyser means 8 serves to analyse the composition of the surface film 7 by making a simple analysis of the optical spectrum (or part of the spectrum) of the transmitted light which may have an alternating component due to the periodic variation of the light intensity. This anlysis serves to determine the degree of light absorption within spectral regions at which the ice, water or oil exhibit significant differences in transmission. In this connection the principal absorption of light by hydrocarbon oil in the 0.8 to 1.0 μm and 1.2 to 1.6 μm wavelength region of the optical spectrum is due to C-H vibrational absorption and this differs significantly from the absorption spectrum of water in the same regions. Water has different absorption characteristic curves which are due to O–H vibrational absorption. Ice has a slightly different absorption from water due to hydrogen bonding mechanisms which cause alterations in the characteristic O–H absorption.

Thus the detector arrangement can identify the composition of the transparent film (e.g. water, ice, oil etc). The detection of water at low temperatures may also serve as a warning of the likelihood of ice film formation.

As will readily be apparent from the foregoing description of one embodiment of the

invention, the surface-condition detection/monitoring arrangment has application in many different fields where the presence of water, ice or oil on surfaces can present serious hazards.

CLAIMS

1. A surface condition detection and/or monitoring arrangement comprising input and output optical fibre means having ends thereof terminated in close proximity with one another at the surface concerned, means for generating and applying light signals to the input optical fibre means which is so arranged relative the output optical fibre means that light emerging from the surface terminated end of the input optical fibre means will be variably reflected and scattered by surface ice, water, oil, etc, into the surface-terminated end of the output optical fibre means and detection means provided at the far end of the output optical fibre means for detecting and analysing the light output to determine and provide an indication of surface conditions.

2. A surface condition detection and/or monitoring arrangement as claimed in claim 1, in which the surface ends of the input and output optical fibre means are flush with and effectively form part of the surface being monitored.

3. A surface condition detection and/or monitoring arrangement as claimed in claim 1 or claim 2, in which the detection means analysies the optical spectrum (or part thereof) to determine the composition of the surface film producing reflection and scattering of the light.

4. A surface condition detection and/or monitoring arrangement as claimed in claim 1 or claim 2, in which the light applied to the input optical fibre means is of periodically-varying intensity in order to provide an alternating component to the light which can be detected by the detection means.

5. A surface condition detection arrangement substantially as hereinbefore described with reference to the accompanying drawing.

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